

# NASA TECH BRIEF

## NASA Pasadena Office



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### Gas-Operated Actuator—A Concept

#### The problem:

To provide a recyclable actuator which does not depend on valves for its operation.

#### The solution:

Use a palladium tube cathode to generate hydrogen by electrolysis; the hydrogen pressure generated inside the tube structure causes expansion of a bellows. The bellows can be retracted when the palladium tube is made the anode.

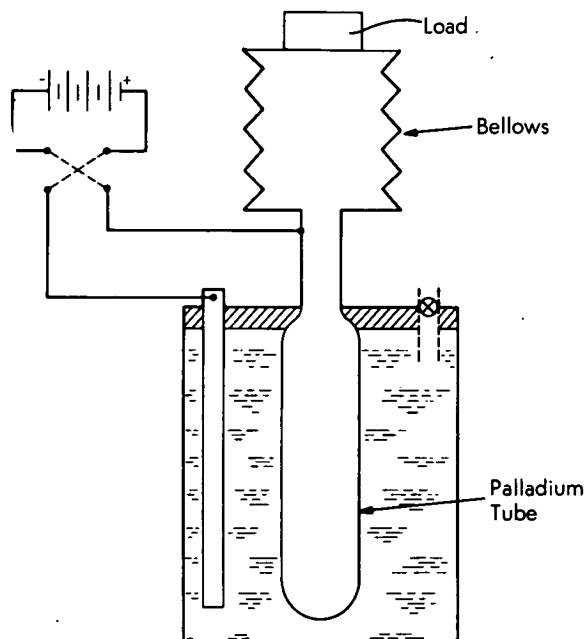
#### How it's done:

The general arrangement of the essential components of the gas-operated actuator is shown in the diagram. The electrochemical cell consists of a body of electrolyte in contact with a tubular palladium electrode and platinum electrode. The tubular electrode may also be made of palladium alloys or other metals which are permeable to hydrogen; alternatively, the tube can be made of porous ceramic coated with a film of palladium or palladium alloy.

The electrolyte is a mixture containing 90% of potassium or sodium hydroxide, 10% lithium hydroxide, and 15% of water, which is the source of hydrogen. The electrolyte must be maintained fluid at an elevated temperature to promote electrolysis and to maintain the palladium membrane at a suitable temperature for diffusion of hydrogen (about 250°C).

Hydrogen gas is generated at the palladium electrode when a source of power, such as a battery, is connected through a reversing switch to the electrodes and the polarity is such that the palladium electrode is the cathode. The hydrogen gas passes through the warm palladium walls into the interior recess of the

tube, and the hydrogen pressure will increase as long as current is allowed to flow until a maximum pressure of about 4 MN/m<sup>2</sup> (600 psig) is obtained; however, in normal use, only enough hydrogen pressure



is generated to expand the bellows and raise the load.

The bellows is retracted by reversing the electrical connections to the electrodes; when the palladium tube is the anode, hydrogen in the tube-bellows system will pass through the permeable wall and be reoxidized to water. Thus, if the electrolytic cell and the bellows system is properly sealed and leak-free, a perfect balance can be maintained and none of the

(continued overleaf)

water originally present in the electrolyte will be lost. If the bellows system has a small leak, a small decomposition current can be made to flow continuously through the cell to replace hydrogen lost by leakage.

**Patent status:**

This invention has been patented by NASA (U.S. Patent No. 3,702,532). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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